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THE PURDUE PERCEPTUAL MOTOR SURVEY:
A VALIDATION STUDY USING A SAMPLE OF GRADE ONE STUDENTS

BY

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A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled . . . . . . THE PURDUE PERCEPTUAL MOTOR SURVEY: A VALIDATION STUDY USING A SAMPLE OF GRADE ONE STUDENTS submitted by Mary Ann Price in partial fulfilment of the requirements for the degree of Master of Education

ABSTRACT

This study attempted a norming and validation of the Purdue Perceptual Motor Survey, using grade one students.

One hundred and ninety seven pupils, 99 boys and 98 girls, participated in the study. These pupils were randomly selected from 13 public schools throughout the County of Strathcona, Alberta, Canada. The schools involved served families from a wide variety of socioeconomic backgrounds.

Nineteen subtests of the Purdue were administered individually to each child in November of their grade one year. Scoring criteria recommended by the authors of the test, Newell C. Kephart and Eugene Roach, were adhered to. Retesting of 28 children from the original sample occurred one week after the initial testing. The Otis Lennon Intelligence and Metropolitan Achievement Tests were administered to each child in September and May, respectively, of the same school year. These group tests were administered routinely as part of the County's core testing program.

In norming the survey, means and standard deviations were obtained for all item and subtest scores, as well as for total test scores.

The effects of sex and socioeconomic background on total test performance was considered using pairwise contrast of means. The internal consistency of subtest and total test scores was assessed using Cronbach's Coefficient Alpha. Test-retest

reliability was obtained for subtest and total test scores.

The validation phase of this study focused on considering statistical support for the five theoretical constructs of perceptual motor functioning which are included in the survey: Balance and Posture; Body Image and Differentiation; Perceptual Motor Match; Ocular Control, and Form Perception. Item scores were subjected to factor analysis for this purpose. The value of the Purdue Survey as a predictor of academic achievement was considered by using Pearson product moment correlations obtained between survey item and Metropolitan Achievement test scores. The relationship between intelligence and perceptual-motor proficiency was also considered by examining correlations between survey item and Otis Lennon scores.

The results of factor analysis carried out on Purdue items suggested support for the five constructs of perceptual motor functioning proposed by Kephart and Roach. However, modifications to the item content of four of the subtests were suggested by both the factor analysis and investigation of intercorrelations between Purdue items.

Internal consistency of Purdue subtests, as assessed by Cronbach's coefficient alpha, was statistically weak, with Ocular Control being the only exception. It was suggested that the recommended modifications to subtest content revealed by the factor analysis could also result in improved internal consistency. More stringent and objective scoring criteria were suggested for improving reliability of the subtest Form Perception. Further research in this area is necessary.

Analysis of intercorrelations between Purdue subtests, academic achievement

and intelligence revealed that Identification of Body Parts was consistently the best predictor of academic achievement and intelligence. Items from the subtests Ocular Control, Balance, and Body Image and Differentiation also correlated with academic achievement. The Kraus-Weber and Obstacle Course items were assessed in this study as being of minimal value in contributing to either construct validity or prediction of academic achievement.

Although significant correlations were found to exist between perceptual-motor efficiency and academic achievement, results were interpreted only as associations.

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CHAPTER I

INTRODUCTION

A common concern expressed by educators today involves the issue of school failure. The concern often stems from frustration over the fact that each year a number of children of average or above average intellectual ability who enter school are unable to cope with the grade one curriculum.

Teachers and parents of these "failing" children have several alternatives available to them. They may retain the child in kindergarten for another year, the expectation being that he or she will succeed if given enough time to mature developmentally. The child may be placed in a transitional grade one or "extended readiness" room, where it is hoped prolonged exposure to readiness activities will equip him or her for formal schooling. If the degree of immaturity is borderline, the child may be placed in the regular grade one program, in the hope that he or she will eventually develop the necessary academic readiness skills.

All of the above mentioned choices present the risk of school failure for the child. Many school systems have recently devoted intensive effort to the prevention of such failure. These efforts have been in large part directed at the early identification and evaluation of the children who are not "ready" to benefit from formal instruction.

Although there is general agreement among educators that some children do

not have the requisite skills for undertaking schoolwork, and that early identification of these children is important, uncertainty and controversy surround the following questions: What is readiness? What are the characteristics necessary for readiness, or academic success? Are certain characteristics more necessary than others? Can the characteristics be identified in young children, and if so, how?

When considering the characteristics which contribute to readiness, the assumption usually is made that certain specific skills and traits, each dependent on their own sequential hierarchy of development, exist, and are necessary for academic achievement. For example, factors which are usually considered as contributors to reading readiness include auditory discrimination, visual discrimination, and adequate vocabulary development. Although these factors are generally thought to be prerequisite for success in the initial stages of reading, research in the area has been conducted in a haphazard piecemeal fashion, resulting in no clear understanding of the nature of the relationships between the factors or of the developmental heirarchy on which they are purportedly based.

In the past, research focusing on readiness has been concerned primarily with predicting reading readiness on the basis of functioning in visual and auditory skills, lateral dominance, and cognitive characteristics such as general intelligence. The results have tended to support the notion that, of these characteristics, mental age is the single best predictor of reading readiness (Holmes, 1961). However, it has become evident that while average intelligence is a necessary prerequisite for academic success, its presence does not guarantee success in reading (Durrell, 1958;

Weintraub, 1967; de Hirsch, Jansky and Langford, 1966; Roa, 1979).

Recent research has tended to focus on the isolation of skills other than intellectual skills which contribute to academic readiness. Specific skills which have been identified as predicting success in academic achievement have tended to fall into the two broad categories of perceptual-motor and cognitive development (Satz and Friel, 1974; Hess, 1974; Anastasi, 1976; Kulberg and Gershman, 1973).

While research has tended to separate the two areas, their development does not occur in isolation. The interrelationships between perceptual-motor and cognitive development have been hypothesized in a number of theories, including those of Piaget (1952), Barsch (1968), Getman (1968), and Kephart (1960). The theories suggest that perceptual-motor development (that is, development in the integration of motor cues, sensory information, and movement) provides the foundation for, and is closely linked to, cognitive development.

Empirical support for this hypothesis is limited, however. Studies investigating the postulated interrelationship between perceptual-motor and cognitive development have usually involved comparing mental and motor scores at various points within a child's life, in an attempt to determine whether early motor indices are in any way predictive of later intellectual development (Bloom, 1964). It is difficult to draw conclusions from such investigations since the type of intelligence tests given during the first 18 months of life are saturated with psychomotor and physical skills. Examples of infant tests commonly used include the Cattell Intelligence Scale (Cattell, 1940), the Bayley Scales of Infant Development (Bayley, 1969), and the Gesell Developmental Scale (Gesell and

Amatruda, 1947). Tests administered at later ages, such as the Wechsler Intelligence Scale for Children (Wechsler, 1949), and the Stanford-Binet Intelligence Scale (Terman and Merrill, 1960), emphasize the assessment of verbal skills and language development. In effect, then, two different sets of data are being collected. This complicates the question of prediction of intelligence in the school years from infant developmental scales.

A limited number of studies do suggest that certain facets of early perceptual-motor functioning affect later cognitive development. Studies involving populations in which early physical movement has been severely restricted, as in the case of swaddling practiced by various cultures, have suggested that cognitive development is not affected by restriction of gross motor movements, and may, in fact, be more advanced (Brazelton, 1972; Liddicoat and Koza, 1972; Goldberg, 1975; Abercrombie, 1964). It is interesting to note that in the populations studied, visual exploration of surroundings, as well as the sensation of motion, providing kinaesthetic-vestibular stimulation, was possible throughout the period of early infancy. The infants in these sample populations were carried about almost constantly by their mothers. On the other hand, there is some evidence suggesting that when early motoric restriction is accompanied by a lack of visual and kinaesthetic vestibular stimulation, later motor and cognitive development are adversely affected (Provence and Lyston, 1962; Danzinger and Frankl, 1968).

It is questionable, therefore, whether active motoric exploration of the environment is a necessary precursor to cognitive development. However, certain types of perceptual-motor stimulation are evidently necessary for later cognitive development.

A number of other researchers have attempted to study the relationship between perceptual-motor proficiency and academic achievement (Skubil and Anderson, 1970; Coleman, 1968; Lowder, 1956; Ismail and Gruber, 1968). Conclusions drawn from these studies must be regarded with caution since the samples included have varied in size, and variables such as age and intelligence have not been controlled. Very few of these studies have concerned themselves with facets of perceptual-motor functioning which may be directly related to academic readiness. They have instead investigated the correlation between perceptual-motor proficiency and academic achievement in school age children. As well, the instruments used in the assessment of perceptual-motor functioning have varied widely, and have included both informally developed and published standardized tests. These factors have made any comparison between studies extremely difficult. However, certain facets of perceptual-motor proficiency are mentioned more frequently than others in the literature as being related to academic achievement (Baker, 1969; Ismail and Gruber, 1967; Kalakian, 1971; Skubil and Anderson, 1970). The factors include Ocular Control, Balance and Posture, Body Image, and Visual-Motor Integration.

I PURPOSE OF THE THESIS

It is evident that there is a need for further investigation to provide empirical support for the theoretical constructs which have been proposed as perceptual-motor abilities. Further research is also required to determine whether functioning in perceptual-motor abilities is predictive of academic success.

A major problem in research investigating both questions has been

the need for satisfactory instruments to assess perceptual-motor functioning. An instrument commonly used in such assessment is the Purdue Perceptual Motor Survey. However, the original norming of the survey was carried out a number of years ago and included a very small sample of grade one students (Roach and Kephart, 1966). The Purdue Survey was developed by and is based on N. C. Kephart's theory of perceptual-motor development. Unequivocal support for Kephart's theory is lacking in the literature.

The present study therefore attempts a norming and validation of the Purdue Perceptual Motor Survey, using a sample of grade one students. The validation phase of the study was concerned with investigating statistical support for the five constructs of perceptual motor development which were postulated by Kephart to constitute perceptual motor functioning (1960). The study also investigated the value of this particular test as a predictor of academic success. The general design of the study was to determine the correlation between perceptual motor skills, as measured by the Purdue Survey, and intelligence as measured by the Otis Lennon Intelligence Test. In addition the correlation between perceptual motor skills and academic achievement as measured by the Metropolitan Achievement Test at the end of grade one was calculated. The effects of sex and socioeconomic status on total test performance was also investigated.

II THE PURDUE PERCEPTUAL MOTOR SURVEY

The Purdue Perceptual Motor Survey was developed to assess perceptual-motor abilities in school age children. It was intended for use by teachers to identify children who lack these supposedly prerequisite skills for

academic success.

The survey consists of 22 items which are intended to assess functioning in the five areas postulated by Kephart as comprising perceptual motor development. The areas include: Balance and Posture, Body Image and Differentiation, Perceptual-motor Match, Ocular Control, and Form Perception.

The authors (Roach and Kephart, 1966) have stated that the survey was developed for use with children between the ages of six and ten years who do not have specific sensory defects affecting motor development. However, the authors also encouraged the use of the survey with children older than ten years who are thought to manifest perceptual-motor disabilities.

III DEFINITIONS OF MAJOR CONSTRUCTS PROPOSED BY KEPHART

Throughout the study, Kephart's definitions of constructs relating to perceptual-motor development are adhered to. A comprehensive discussion of the constructs is found in Chapter Two. Following are the definitions given by the authors for the five ability constructs:

1. Balance and Posture refers to components of motor performance which involve body alignment and center of gravity control. Chaney and Kephart (1968, p. 9), state:

> Through the activities of Balance and Posture, the child determines where the line of gravity is and the direction of its force....He must learn to identify the line of gravity through his own body and become constantly aware of the relationship between the position of his body in space and the direction of this force.

Balance and Posture is assessed through performance on four items, including three walking board tasks and one jumping task. The three walking board

tasks are used to measure dynamic balance and to answer the question, "Has the child developed enough postural flexibility to meet new situations requiring balance . . ." (Roach and Kephart, 1966, p. 29)? The jumping tasks are used to detect children with laterality, body image, rhythm, or neuromuscular control difficulties (Roach and Kephart, 1966, p. 32).

2. Body Image and Differentiation: Body Image is defined as "the body scheme or total sensory impression of one's own concept or self-picture of one's body in space" (Godfrey and Kephart, 1969, p. 103). Differentiation implies a perception or image of one's own body parts and "the ability to sort out and use independently different parts of the body in a specific and controlled manner" (Chaney and Kephart, 1968, p. 135). The tasks included in the Purdue Survey to assess Body Image and Differentiation are:

(a) Identification of Body Parts. The child is instructed to touch nine different body parts.

(b) Imitation of Movement. In this task the child reproduces 17 different arm positions which are demonstrated by the examiner. These involve unilateral, bilateral, and contralateral movement.

(c) Obstacle Course. The child is given the task of stepping over, under, and between a stick and a wall. The child's performance on this task provides information concerning his spatial reaction to objects around him.

(d) Kraus-Weber. This test was first used by Kraus and Weber as a measure of muscular strength (Kephart, 1960, p. 42).

(e) Angels-in-the-Snow. This task is used to detect problems in

neuromuscular differentiation and specific problems with right or left sidedness.

3. Perceptual-Motor Match refers to the ability to coordinate perceptual and kinaesthetic experiences in order to gain meaning from the environment. A perceptual-motor match is said to occur when perceptual information and motor information regarding a given occurrence come to mean the same thing (Chaney and Kephart, 1968, p. 17). The Purdue Survey items designed to assess perceptual-motor match include four chalkboard tasks: drawing a circle; drawing two circles simultaneously using both hands; drawing a lateral line from one prescribed point to another; and drawing two vertical lines simultaneously. This task is designed to reveal difficulty in directionality (that is, the projecting of all directions from the body out into space: right, left, up, down, fore and aft) and in perceptual-motor matching.

4. Ocular Control is defined as "the ability of the child to establish and maintain visual contact with a target (Roach and Kephart, 1966, p. 58)." The tasks used to assess ocular control involve following a moving target with both eyes, as well as with one eye at a time.

5. Form Perception refers to the ability to perceive a form as an integrated whole. The child is required to copy simple geometric forms. This task is used to examine two skills: adequate form perception and adequate spatial and construction judgement (Roach and Kephart, 1966, p. 62-68).

IV SUMMARY

The present study investigated both the validity of the

theoretical constructs upon which the Purdue Survey is based, and the survey's effectiveness as a predictor of academic success using a sample of grade one children.

CHAPTER II

RELATED RESEARCH

The review of research related to this study is divided into four areas. The first area outlines the background and rationale for several related perceptual-motor theories; the second reviews research investigating the hypothesized perceptual-motor foundation for cognitive functioning; the third investigates empirical support for postulated constructs as components of perceptual-motor functioning; and the fourth considers research investigating the relationships between perceptual-motor functioning, cognition, and academic achievement. Wherever possible, particular attention is given to research related to the Purdue Perceptual Motor Survey.

I THEORETICAL BACKGROUND AND RATIONALE

Theories in the disciplines of special education, physical education, psychology and optometry have referred to the perceptual-motor basis of cognitive development. A brief review of ideas of some of the most outstanding contributors from these disciplines will follow. Greater emphasis will be placed on the work of Newell C. Kephart, which provides the theoretical basis for the Purdue Perceptual Motor Survey.

The early work of Montessori (1912) emphasized the relationship of

the education of the senses and motor experience to child development. The Montessori approach to education suggests that sensory experience, occurring mainly through movement, allows the child to observe and judge his surroundings. Sensory experience, in turn, assists the development of intelligence.

Piaget's observations and subsequent theory (1952) emphasized the relationship between sensorimotor and cognitive development. He proposed four major stages of development: the sensorimotor stage, the preconceptual stage, the concrete operational stage, and the formal operational stage.

The sensorimotor stage, which covers the first two to three years of life, utilizes experiences which form the basis for later more complex perceptual and conceptual development. Adequate development during the sensorimotor stage is considered a prerequisite for subsequent development.

Barsch (1968) also subscribed to the theory that perception is the foundation of intelligence. He proposed a theory of movement and its relationship to learning, termed movigenics. Movigenics represents a study of movement patterns and their origin, development, and relationship to learning.

Barsch proposed the following hypotheses which are basic to his theory:

1. The fundamental principle underlying the design of the human organism is movement efficiency. Man is designed to move.

2. The primary objective of movement efficiency is to economically promote the survival of the organism.

3. Movement efficiency is derived from the information the

organism is able to process from the surroundings. The organism is defined as a dynamic being capable of converting data obtained from energy forces into information.

4. The human mechanism for transducing energy forms into information is the percepto-cognitive system. Six "modes" make up this system: gustatory, olfactory, tactual, kinaesthetic, auditory, and visual.

5. The terraine of movement is space.

6. Movement efficiency, a measure of the organism's survival potential, is developed in a climate of stress. Inefficiency in movement causes the organism to depend upon others for survival.

7. The adequacy of the feedback system is critical to the development of movement efficiency.

8. Movement efficiency develops in segments of sequential expansion.

9. As the organism matures through movement, symbolic fluency --language--replaces motoric modes of gaining experience and comprehension.

To summarize, Barsch suggests that movement efficiency is the basic principle underlying the development of the human organism. Man learns to move, and then moves to learn.

Getman (1962) also proposes that motor development contributes to visual development and later learning. He postulates four "L's" which contribute to learning. According to Getman, the child initially acquires information about his surroundings through movement (Locomotion) and kinaesthetic feedback from this movement. Further information is gained when movement results in a change in

Location. The child then is able to inspect his environment from different perspectives. The exploration of the child's environment involves the use of other senses: tactile, visual, auditory, olfactory, and gustatory. Eventually the child "Labels" or organizes his experiences, an achievement followed by the development of Language. The four "L's," Locomotion, Location, Labels, and Language do not develop in isolation, but are interdependent.

Ayres (1963) has not proposed a theory relating to perceptual-motor functioning, but she has concentrated on investigating the nature of perceptual-motor dysfunction. Her belief is that this approach may be more useful in leading to an understanding of the relationship between perceptual-motor functioning and academic learning. Underlying her approach to treatment of dysfunction is her conditional acceptance of the principle of normal ontogenetic development:

> One of the most generally accepted postulates on which treatment of motor dysfunction is based is the recapitulation of the sequence of development. Accordingly, theories regarding the ontogeny of perceptual-motor abilities provide a basis for treatment of dysfunction in this area of human behavior (1963, p. 221).

Ayres (1975) suggests educators should temper their ideas of a rigid developmental hierarchy with the following points:

1. Developmental stages are not arrived at in isolation. There is constant interaction and interdependency in the various areas, tending to produce a spiral of growth.

2. The understanding of some of the sequences of neural development which are important contributors to academic learning is incomplete and may be totally lacking in validity.

3. Some neural systems may rely more heavily on sequential development than do others.

Ayres strongly emphasizes the importance of intersensory integration in the development of perceptual-motor skills. Sensation received through several different modalities must be integrated into a meaningful unit, providing the individual with information about his environment and his relationship to it. Ayres also considers development of the following skills to be particularly important in contributing to perceptual-motor growth: bilateral coordination*, spatial orientation, form and space perception and proprioception*.

The theory of perceptual-motor development advanced by Kephart (1960) suggests the inclusion of both normative and developmental views. That is, the child processes information in a certain way at one stage and learns to solve increasingly complex problems. The ability to process leads to the evolution of new methods of processing, which are used in turn to acquire further, advanced ways of processing. Each normative level, according to Kephart, is characterized by a particular type of processing. Developmental sequencing is therefore unidirectional and irreversible.

Seven stages of development are hypothesized by Kephart, each acting as a foundation for the next:

1. Motor Stage: The child begins to control body experiences, and also to contact the environment.

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*See Glossary for complete definition.

2. Motor Perceptual Stage: Controlled hand movements occur, with controlled eye movements following in development. Visual percepts become matched to kinaesthetic* percepts.

3. Perceptual-Motor Stage: Visual exploration of the environment begins to replace tactile and kinaesthetic exploration. Vision provides a more efficient and faster method of exploring the environment.

4. Perceptual Stage: Vision is used to explore and to make comparisons between objects. Motoric involvement is no longer necessary. The accuracy of visual percepts established at this level depends on a kinaesthetic frame of reference having been established in previous stages.

5. Perceptual-Conceptual Stage: Percepts are organized to form concepts.

6. Conceptual Stage: Concepts broaden to involve percepts acquired from past and present. Language becomes very important as an efficient method of organizing abstractions. The conceptual stage is achieved at approximately age seven.

7. Conceptual-Perceptual Stage: Concepts now dominate percepts. That is, the child's idea of, or knowledge of what he should see, dominates what he sees. The ability to synthesize percepts is highly evident.

Development is affected by varying factors. Kephart draws a distinction between development as affected by retardation and cultural deprivation, in which progress is slower, but the sequence normal, and disturbed neurological

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*See Glossary for complete definition.

functioning, in which progress and sequence are disrupted.

Kephart states that higher forms of mental behavior have their basis in early motor learning. "There is evidence that the efficiency of the higher thought processes can be no better than the basic motor abilities on which they are based" (1960, p. 81). During infancy and early childhood, it is evident that motor activity is closely related to mental activity. Later on in life, motor behavior may also be involved in non-observable activities such as thinking and problem solving. Motor behavior may involve increased tension throughout the body or localized tension in various muscle groups. An important aspect of motor development is posture, through which the child establishes a consistent orientation to the environment, and an understanding of gravity. Kephart states that posture must be flexible to allow for a larger range of movement and more elaboration.

Laterality, "the internal awareness of the two sides of the body and their difference" (Kephart, 1960, p. 88), appears to be the first spatial reference to develop. Laterality is a learned attribute developed through experience and experimenting. The differentiation between the two sides of the body arises from the ability to balance. The child must experiment with balance before he develops an awareness of left and right. Laterality is important because it forms the basis for projection onto the environment: directionality. The concepts up-down, and left-right have no meaning except in relationship to the awareness of position which first develops in the individual.

Directionality, then, is thought of as the extension of laterality to objects in external space. It develops first in relation to the child. Egocentric

localization develops into objective localization. An example of this development may be seen when the child comes to know that placing a ball on the left side of the chair is not necessarily the same as placing a ball near <u>his</u> left side. Directionality is also dependent upon accurate eye movement, since the directionality of objects in space which was once determined kinaesthetically is now determined through vision. The development of the ability to cross the body mid-line with the hand is related to directionality. In the new-born, movements are from outside-in, toward the body center, so that the right arm moves from right to left and the left arm moves from left to right. This tendency remains, according to Kephart, and the child must learn to maintain arm movements from left to right even though the mid-line is crossed. This also holds true for eye movement. Laterality and directionality are thought by Kephart to have a very important relationship to academics.

The sense of body space, body orientation, and body image is viewed as important by Kephart since it is the base upon which understanding of other spatial relationships is formed. Body image awareness acts as a reference point for the development of directionality and laterality. Locomotion must be established as a generalization before the environment can be explored and any consistent understanding of it obtained. Otherwise the individual would focus on the movement itself. Contact with objects permits exploration and must also be a generalization so that the information can be gained in a systematic, uninterrupted fashion. According to Kephart, a child who is physically handicapped can develop motoric generalizations by substituting other movements. Kephart gives the

example of a physically handicapped child, unable to walk, who develops posture-balance generalization through sitting.

Basic to Kephart's theory are his explanations regarding the following constructs related to perceptual-motor functioning: differentiation, perceptual-motor match, intersensory integration, conceptual development, generalization, and form perception. A brief discussion of each of these constructs follows.

1. Differentiation: Several reflexes are present in the neonate, and he is also capable of generalized movement. This generalized movement is too gross to allow effective interaction with the environment; the reflex behavior is too specific. Therefore, according to Kephart, the development of movement differentiation is necessary. This development occurs in cephalo-caudal and proximo-distal directions.

2. Perceptual-Motor Match: Basic to Kephart's theory is his idea of perceptual-motor match. Perceptual and motoric information must be related and coordinated, or input will be meaningless and will have no relation to motoric behavior. Kephart stresses that initially motoric-kinaesthetic information provides the basis for the match: "Perception is matched to motor, not the reverse ....It is important that the match be made in the proper direction" (1960, p. 22).

According to Kephart, perceptual-motor match helps the child establish form constancy, since visual ideas of distance and shape are kinaesthetically based. An accurate figure-ground relationship must also be established to ensure accurate processing of perceptual material and development of

the perceptual-motor match. Kephart hypothesized that kinaesthetic figure-ground ability provides the basis for later development of differentiation of visual and auditory figure-ground. Kinaesthetic figure-ground developes as the child learns selectively to use certain muscle groups for specific tasks. Kephart also hypothesized that the hyperkinetic child is one who has never been able to establish kinaesthetic figure ground. In such children the tone of all muscle groups remains uniformly high.

Development of kinaesthetic figure-ground and the perceptual-motor match contributes to the development of motor control. Systematic exploration of the environment is possible once motor control is present, leading to the systematic processing of perceptual data. Relationships between objects can now be established. The child comes to rely increasingly on vision as a faster and more efficient method of processing data. Perceptual information must have continuity; continuity which is obtained through motoric manipulation. Kephart hypothesized that if motoric manipulation is faulty, there will be a distortion of perceptual information which the child receives.

3. Integration: Perceptual information is processed through intersensory integration, a "welding" of data through several senses. Intersensory integration helps ensure that the child responds to a total stimulus rather than to isolated bits of information. When there is interference with the integration of perceptual data, the child has difficulty interpreting the information. Kephart suggested that a dominant sense avenue is usually established in order to simplify the integration process. He speaks of the "visile" child, one whose dominant sense avenue is visual, and the "audile" child, who processes information primarily

through the auditory sense avenue.

4. Concept Development: According to Kephart, perception forms the basis for concept development. Initially, objects are categorized through perception. Perceptual categorization vastly increases the efficiency of data processing, permitting the child to move from concrete to abstract reasoning. Kephart concluded that accurate abstract reasoning is based, therefore, on the proper sequencing of earlier developmental stages. "Only when concepts are reality oriented does the behavior based on conceptual manipulations 'come out right' when it is exteriorized" (1960, p. 37).

At the conceptual level, furthermore, concept begins to affect percept. The child who has developed effective concepts and classifications now uses concepts rather than the laborious process of first perceptually exploring. That is, when he looks at an object he classifies it first and then may proceed to analyze it perceptually. The child can now also predict through perceiving only parts of objects. According to Kephart, processing from incomplete information accounts for the distortion of percept to fit concept. An example of this distortion is found in the variations that may occur in "eye witness" accounts of accidents. To a certain extent, we learn to believe what we think we are going to see. The child in this final stage of development is now free of both concrete environment and time since he is capable of conceptualizing and predicting.

5. Generalization: Kephart places heavy emphasis on the concept of generalization. Growth and development involve the acquisition of "generalizations" which build on each other. Generalizations are made possible through "patterns of function" in the central nervous system. Patterns of function allow for

integration of information from several senses at once. The child then finds that it is no longer necessary to attend to separate elements of perceptions. Instead, qualities of patterns can be reacted to. Kephart stated that patterns of functions underlying generalizations are dynamic and selective. They change and adapt accordingly to specific situations, and they screen out irrelevant information.

According to Kephart, the development of the ability to generalize is hampered in the learning disabled child. Data are not integrated, but remain isolated and independent. Since the impairment to central nervous system functioning has usually occurred around the time of birth, the development of patterns of generalization are interfered with. The ability to generalize never occurs to the necessary degree in learning disabled children.

Kephart describes four characteristics relevant to the development of the ability to generalize:

(a) Initially, an isolated individual piece of information is acquired by the child at a very simple level. The acquisition is similar to rote learning, that is, the learning of isolated pieces of information which are not necessarily applied to other situations.

(b) Elaboration occurs when a number of similar, but not identical experiences are added to the isolated pieces of information. A relationship must be established between these experiences for a pattern of neural functioning to develop. Kephart stresses the effect of play on elaboration. During play, the child experiments with his environment and develops alternatives which will later serve him in problem solving situations.

(c) Rigidity is a factor affecting the development of elaboration. It is a tendency not to vary activity, but to repeat the same act again and again. Kephart makes a distinction between perseveration, a characteristic present in learning disabled children, and rigidity: the perseverative child seems unaware of a change in stimulus while the rigid child is aware but chooses not to vary his/her response.

(d) The final step in generalization is integration: "the process by which the data from elaboration are tied together...into an inflected whole" (Kephart, 1960, p. 77). Integration allows for the simultaneous availability of a variety of data which may be applied in problem solving.

6. Development of Form Perception: The "globular forms" which the child first perceives have no real details. The child gradually differentiates a "signal quality" from the globular form and continues to differentiate further details. Kephart postulates that the ability to differentiate is affected greatly by the environment and is facilitated by movement:

> Active motor exploration may well be required before the necessary differentiations are possible and before they result in valid perceptual elements (1960, p. 127).

Form perception appears to be a learned skill. Kephart cites the example of individuals who are born blind and who later acquire vision as support for this hypothesis. The blind person who later acquires sight is unable to perceive forms until he is taught. The child who has not been able to develop integrated form perception normally characteristically responds to elements of a situation rather than to the total situation.

The review of theories as presented by Kephart, Barsch, Ayres and Getman suggests several areas of agreement:

1. Perceptual-motor development occurs in a sequence of stages, with each stage being essential to the next.

2. A relationship exists between adequate perceptual-motor functioning and cognitive growth. The first stage of perceptual cognitive development, occurring in infancy, is based in movement patterns and motor development.

3. The integration of sensation received through several modalities into a meaningful unit is basic to perceptual-motor functioning.

II EVIDENCE FOR A PERCEPTUAL-MOTOR BASIS FOR COGNITIVE FUNCTIONING

Although there has been considerable theoretical agreement on the influence of perceptual-motor development on cognitive functioning, empirical evidence supporting the theoretical assumptions has been limited.

Dennis and Dennis (1941) conducted an investigation of the effects of Hopi Indian swaddling practices on motor development. At age one year, the children who had been swaddled were administered the Viennese Test of Motor Development. No delays in motor development were noted. A similar study later administered by Danzinger and Frankl (1968) involved Albanian children. Results of testing with these children at age one year indicated a significant degree of motor impairment. Both groups of infants were restricted to a similar degree in terms of motor activity; both were attached to boards throughout most of each day.

However, the Hopi infants had been attached to their mothers' backs and carried around throughout the day; the Albanian infants were generally left in one place. The important factor contributing to motor development appears to be related to the enriched visual and kinaesthetic-vestibular experiences. Several other cross cultural studies have supported the importance of these experiences. Leiderman and Leiderman (1975), investigating the development of African infants, noted their superiority on the Bayley Mental Development Index. Superiority in the development of language (Liddicoat and Koza, 1972), object permanence (Goldberg, 1975), and in social responsiveness (Ainsworth, 1967) have also been noted in African infants. With the exception of the Albanian group, the infants in the cultural groups studied all received a great deal of visual and kinaesthetic-vestibular stimulation, since they were carried almost constantly throughout the first months of life.

Research conducted with children who were restricted in their ability to move due to cerebral palsy (Abercrombie, 1964) indicated that later perceptual and intellectual ability was not impaired by the restriction. He concluded that concepts were acquired through compensatory channels. It would seem reasonable to assume that the kinaesthetic-vestibular stimulation provided to these children through physiotherapy and prosthetic motion was sufficient to allow normal development.

It would be an obvious exaggeration to state that the development of intelligence is totally dependent on early motoric experiences. However, there is both theoretical and empirical support for the idea that early sensorimotor

experiences and stimulation during the first year of life can have long lasting effects on later development.

III EVIDENCE RELATED TO CONSTRUCTS OF PERCEPTUAL-MOTOR FUNCTIONING

Hypothetical constructs underlying perceptual-motor functioning have been proposed by a number of researchers. As well, a variety of test batteries have been made available for assessing perceptual-motor development in children. However, statistical support for the existence of these factors is extremely limited.

Ayres (1965) attempted to identify perceptual motor factors affecting academic achievement. Using a sample of 100 children with and 50 children without suspected perceptual deficits, she administered a battery of 35 perceptual motor tasks. A factor analysis was carried out with the data. Five major patterns or syndromes characteristic of perceptual motor dysfunction were identified by the factor analytic study: (1) perceptual dysfunction of form and position in space; (2) tactile defensiveness, associated with faulty tactile discrimination and hyperactive-distractible behavior; (3) deficits in bilateral integration; (4) deficits in visual figure ground discrimination, and (5) developmental apraxia which is defined as impairment of ability to execute complex coordinated movements.

The results of Ayres' study indicated that perceptual deficits in children show affinities resulting in syndromes which are not found in children from a random population. Ayres concluded:

> The syndromes do not reflect inherent categorization based on individual sensory modalities but seem, to some degree, to be expressive of rather

> specific mechanisms by which intersensory and motor information is coordinated to permit development and manifestation of perceptual-motor ability (1965, p. 367).

Musgrove (1970), using 84 first and second grade children, identified nine factors common to both the Purdue Perceptual Motor Survey and the Cratty Perceptual Motor Battery (Cratty, 1966). The factors identified by Musgrove were: (1) Visual Tracking; (2) Visual Discrimination and Copying of Forms, which involved copying of geometric forms; (3) Visual Discrimination and Copying of Rhythmic Patterns, which involved copying of rhythmic patterns; (4) Verbal Body Image (that is, identifying body parts on command); (5) Dynamic Balance; (6) Spatial Body Perception, involving the movement of the body and specific body parts in space; (7) Postural Maintenance, the ability to maintain posture while carrying out complex motor tasks; (8) Visual Discrimination and Copying of Motor Patterns, defined as the imitation of static and dynamic motor patterns upon visual cues; and (9) Gross Agility, involving the performance of simple gross motor tasks.

In summary, few attempts have been made to establish statistical support for theoretical constructs related to perceptual-motor functioning. Factorial studies which have been carried out suggest that discrete areas of perceptual-motor functioning do exist and can be assessed by various batteries which have been developed.

IV RELATIONSHIP BETWEEN PERCEPTUAL MOTOR FUNCTIONING, INTELLIGENCE, AND ACADEMIC ACHIEVEMENT

Kephart (1960) was one of the first to propose a cause and effect relationship between perceptual-motor functioning and academic achievement.

While research dealing specifically with the Purdue Survey is limited, there is an abundance of research dealing with the relationship between perceptual-motor functioning and academic achievement. Research related specifically to performance in the areas of reading, mathematics, and spelling will be discussed below.

In considering the differences between normal and poor readers, researchers have used a wide variety of tests and instruments designed to assess visual-motor and visual perceptual development and academic achievement. Other factors, including weak controls in defining subject intelligence and the use of rather arbitrary criteria in defining the "poor reader," have contributed to the conflicting results.

Skubil and Anderson (1970) investigated the relationship between perceptual-motor ability and academic achievement. Their population consisted of 86 fourth graders of normal intelligence. Forty-five high achievers were identified through results obtained on the Stanford Achievement Test. Performance on 11 perceptual motor tasks, devised by the authors, was measured. The results indicated that high achievers performed significantly better than low achievers on six of the 11 perceptual-motor tasks.

A significant correlation was also obtained between perceptual-motor scores and performances on both the California Test of Mental Maturity and the Stanford Achievement Test.

Coleman (1968) assessed 87 first through sixth grade subjects who showed severe reading deficits. Using the Purdue Perceptual Motor Survey, he identified half the children as having significant deficits in perceptual-motor

functioning. The criteria for inclusion into the reading disabled population were unclear. He included teacher's ratings and unspecified tests.

Using a population of 1,510 children in grades one through three, Lowder (1956) investigated the relationship between perceptual ability and school achievement, as assessed by teacher ratings of student progress. Perceptual ability was judged by performance on copying seven geometric figures. (These are the same forms included in the Purdue Perceptual Motor Survey.) Results indicated a significant relationship between perceptual ability and school achievement.

Ismail and Gruber (1965) studied the relationship between physical development, motor aptitude, intelligence and academic achievement. A population of 211 children, 122 boys and 89 girls between the ages of ten and 13, was used. The Otis Lennon Intelligence Test, Stanford Achievement Test and 37 motor aptitude test items were administered to the students. Twelve of these items are very similar to the tasks designed to assess balance and posture as found in the Purdue Survey. Significant relationships were found to exist between intelligence, academic achievement and tasks of balance and coordination.

A similar study carried out by Ismail, Kane, and Kirkendall (1968), using British primary school children as subjects, revealed significant positive correlations between intelligence, achievement and tasks of balance and coordination.

Research conducted by Belmont and Birch (1965), using a population of learning disabled readers and a control group of normal readers, found that the learning disabled readers were characterized by confusion in the right-left identification of body parts (laterality as defined by Kephart), and by defects in body

schema (Kephart's body image).

Kalakian (1971), using a sample of 20 educable mentally handicapped children (mean chronological age 10.4 years), studied the relationship between academic achievement as measured by the California Achievement Test, and perceptual-motor efficiency as measured by the Purdue Perceptual Motor Survey. Results indicated seven significant correlations between perceptual motor efficiency and academic achievement. These included: (1) Purdue composite score and arithmetic achievement; (2) Purdue composite score and composite achievement score; (3) Balance and Posture and reading; (4) Balance and Posture and arithmetic; (5) Balance and Posture and total achievement; (6) Perceptual Motor Matchand arithmetic; and (7) Ocular Pursuits and arithmetic. Thirty significant correlations between individual Purdue items were also found. No attempt was made to factor analyze the data, but the author suggests that some of the Purdue items tended to measure common characteristics, and could possibly be excluded from the survey in the future.

Baker (1969), in a study involving 16 grade one children, identified the Purdue subtests Balance and Posture, Body Image and Differentiation, and Ocular Control as contributing to the prediction of academic achievement. Balance and Posture items, as well as Body Image and Differentiation, correlated significantly with achievement in arithmetic, spelling, and reading. Ocular Control items correlated significantly with achievement in arithmetic.

In a study investigating relationships between perceptual motor proficiency, intelligence and academic achievement, using a sample of grade three

students, Little (1971) found that Identification of Body Parts, Jumping and Chalkboard items from the Purdue Survey were the best predictors of achievement in reading and arithmetic. Ocular pursuit items correlated significantly with reading achievement. The Bender Visual Motor Gestalt Test (1946), which is similar to the Purdue Form Perception subtest, was used by Koppitz (1974) in a study attempting early identification of learning disabled students. Performance on the Bender test was found to be related to achievement in arithmetic. Other researchers have suggested that an arithmetic disability may be part of a cluster of characteristics. This was first suggested by Gerstmann (1940), but has more recently been supported by Rourke (1978) and Quiros and Schrager (1978). Characteristics which have been associated with arithmetic disability include dysgraphia, a disorder in correctly tracing shapes and in forming letters; finger agnosia, a lack of ability to attach meaning to sensory input received by the fingers of either hand; and right-left disorientation.

In summary, a review of related literature has suggested support for the existence of a relationship between certain aspects of perceptual-motor proficiency and academic achievement. Of the Purdue Survey subtests, Ocular Control and Balance and Posture were mentioned more frequently as correlating with academic performance, while the item Identification of Body Parts correlated consistently with academic achievement and intelligence.

CHAPTER III

METHOD

I INTRODUCTION

This chapter describes the sample used in this investigation, the methods of collecting data, the statistical analysis of the data, and the proposed hypotheses of the study.

The investigation was primarily concerned with the norming and validation of the Purdue Perceptual Motor Survey, using a sample of grade one students. The norming consisted of obtaining means and standard deviations for all item and subtest scores, as well as for total test scores.

The effects on norms of sex and socioeconomic background were considered using pairwise contrast of means.

The internal consistency of subtest and total test scores was assessed using Cronbach's coefficient alpha. Test-retest reliability was obtained for subtest and total test scores.

The validation phase of this study focused on considering statistical support for the five theoretical constructs of perceptual motor functioning which are contained in the survey: Balance and Posture; Body Image and Differentiation; Perceptual-Motor Match; Ocular Control, and Form Perception. Item data were subjected to factor analysis for this purpose.

The value of the Purdue Survey as a predictor of academic achievement was considered by investigating correlations obtained between survey item and achievement test scores. The relationship between intelligence and perceptual motor proficiency was also considered by examining correlations obtained between survey item and Otis Lennon scores.

II DESCRIPTION OF SAMPLE

The sample used in this investigation consisted of 197 grade one students. The 99 boys and 98 girls were drawn from a total population of 1,097 grade one students enrolled in 17 schools throughout the public school system in the County of Strathcona, Alberta, Canada. Random selection was ensured through the use of Fisher and Yates (1948) table of random numbers

The use of a sample considerably larger than that used in the original norming of the survey was thought advisable: "The basic justification of statistical inference is that the distribution which is obtained from a random sample tends to resemble the population from which it is drawn. This tendency increases as the size of the sample increases (Walker and Lev, 1958, p. 82)."

The children in the sample ranged in age from 5.6 to 7.0 years with a mean age of 6.2 years and a standard deviation of 3.8 months.

The intelligence quotient scores of the children in the selected sample, as measured by the Otis Lennon Mental Ability Test, Primary II, Form J, ranged from 81 to 150. The children had a mean intelligence quotient of 115.948 with a standard deviation of 13.183.

The normative sample was divided into six socioeconomic status

groups. Criteria used in making the socioeconomic divisions were those originally used by Kephart and Roach. The fathers' occupational status in each group was as follows: Group I - professional; Group II - semi-professional; Group III - farmers; Group IV - clerks, service and office workers; Group V - skilled labour; Group VI - unskilled labour. Information regarding father's occupation was obtained from school records. Over half of the sample population came from SES groups IV and V. Table I presents the distribution of socioeconomic categories of the normative sample.

TABLE I

DISTRIBUTION
OF
SOCIOECONOMIC CATEGORIES

GROUP	n
I	9
II	44
III	4
IV	62
V	61
VI	17

III DESCRIPTION OF THE PURDUE

Four test items are used in assessing the development of Balance and Posture. Three of these items involve the walking board, a two by four board eight to 12 feet long, placed on brackets so that it is at least six inches off the floor. Children are asked to walk forward, backward and sidewise on the board. In each case they are asked to go to the end of the board and then return to the examiner in the same fashion. The Jumping item is the fourth included under Balance and Posture. It consists of eight basic tasks: jumping forward with both feet together; jumping forward on the right foot; jumping forward on the left foot; skipping across the room; hopping alternately, once on the right foot and once on the left foot (this must be maintained for more than 30 seconds); hopping alternately, twice on one foot and twice on the other foot; hopping alternately, twice on the right foot and once on the left; and hopping alternately, twice on the left foot and once on the right.

Five items are used in determining the level of development in Body Image and Differentiation:

1. In Identification of Body Parts, children are asked to touch their shoulders, hips, head, ankles, ears, feet, eyes, elbows and mouth.

2. In the next item, Imitation of Movement, students face the examiner while standing and are asked to match a series of semaphore movements made with the arms.

3. The Obstacle Course consists of three simple tasks. The child is asked to step over a stick held at knee level, duck under a stick held at

chin level, and to go sideways between a wall and the end of a stick without touching either.

4. The Kraus-Weber item originated as a test of physical fitness and strength. From a face down, prone position, the child is asked to (a) raise his chest off the floor for ten seconds and (b) raise his legs off the floor for ten seconds.

5. Angels-in-the Snow is made up of ten separate tasks. While lying on his back on the floor, the child is asked to move his arms and legs in an arc away from his body and then back again. The ten movements involved are: the right arm alone, the left arm alone, right leg alone, left leg alone, both arms together, both legs together, the left arm and left leg together, the right arm and right leg together, the right arm and left leg together, and the left arm and right leg together.

The Perceptual Motor Match subtest includes five items: Chalkboard Circle, Double Circle, Lateral Line, Vertical Line and Rhythmic Writing. Rhythmic Writing was not administered in this study since its use is recommended with children eight years of age or older. The chalkboard tasks consist of four items: a) drawing a circle; b) drawing two circles simultaneously with both hands; c) drawing a lateral line from one point to another; and d) drawing two vertical lines simultaneously.

A series of four tasks is included in the subtest Ocular Control. Children are asked to follow a light with their eyes as it is moved horizontally, vertically and diagonally. This procedure is followed using both eyes, the right eye alone and the left eye alone. In the final item, Convergence, the light is

moved toward the face from a distance of 20 inches, with the child being required to follow it with both eyes.

In the assessment of Form Perception, seven simple geometric forms are copied by the child: circle, cross, square, triangle, divided rectangle, horizontal diamond and vertical diamond. As recommended by the authors, only the first five forms were administered to children in this study.

IV TESTING PROCEDURE: THE PURDUE

Testing was carried out by 16 female grade 12 students and their instructor in November of 1978. Before testing with the grade one students was initiated, the examiners were given six hours of classroom training in working with young children and in familiarization with the structure of the survey. Experience in administration of the survey was gained while working with 28 grade two students from an elementary school in the County of Strathcona.

Two examiners were assigned responsibility for each of those items of the survey which require skill in both observation and giving directions. These items were: Walking Board; Jumping; Angels-in-the Snow; Chalkboard; and Ocular Pursuit. In each of these, one examiner was assigned to administer the item, the other to observe and record. Examiners assigned to a particular subtest were responsible for the administration of only that subtest with the total sample. Testing was monitored throughout by the writer.

Students from the selected sample were tested in their home schools after parental consent for participation was obtained. Testing was carried out either in regular classrooms or gymnasiums. Ten stations, each representing a survey task,

were set up in the rooms before students arrived. In this way it was possible to bring students out of their classrooms in groups of ten. Each student was then sent to one testing station, moving from station to station until all items of the survey had been administered. The testing was carried out during regular school hours and the time for administration varied from 20 to 30 minutes.

All items of the survey, with the exception of Rhythmic Writing, were administered to all subjects. This omission was in accordance with the recommendations of the authors of the survey.

Twenty-eight students from the original sample were reassessed one week after the initial testing. The retest was administered by the writer.

V SCORING PROCEDURE: THE PURDUE

Although the original scoring criteria suggested by the authors of the survey were adhered to, the format of the scoring sheet was altered to allow for the inexperience of the examiners. The revised format, found in Appendix A, was developed to ensure that the examiners were required only to check observed behaviors during administration of the survey items. Final scoring of the survey was carried out by the writer.

Performance on the survey items was rated on a scale of one to four, with four being the highest ranking possible. Subtest scores in each of the five areas of perceptual motor development were calculated by totaling the relevant item scores. A total score was obtained for each child by totaling scores obtained on each item in the survey.

VI OTHER TESTING INSTRUMENTS

The two group tests described below, the Otis Lennon Mental Ability Test Primary II, Form J, and the Metropolitan Achievement Test, Primary I, Form F, were administered to all children in the sample during October 1978 and May 1979, respectively. These tests are part of the County of Strathcona's core testing program and as such are administered routinely during each school year by classroom teachers. Scores obtained by children in the selected sample were made available by the schools involved.

The Otis Lennon Mental Ability Test, Primary II, Form J, was designed as a group intelligence test, for use with children in the first half year of grade one. Administration of the test is carried out in two sessions, with the total time required being 30 to 35 minutes. No reading is required. Test items consist of pictures and instructions are given orally by the examiner. The publishers of the test indicate that the mental processes of classification, following directions, quantitative reasoning and comprehension of verbal concepts are sampled.

Deviation I.Q.'s obtained on the Otis Lennon have a mean of 100 and a standard deviation of 16. The test was standardized in the United States in 1966.

The Metropolitan Achievement Test, Primary I, Form F, is a standardized group test designed for use with children in the latter half of grade one. Administration of the test is carried out in three sessions. Total administration time is 90 minutes. The test consists of four subtests: Word Knowledge, Word Analysis, Reading and Mathematics. A Total Reading score is also obtained by adding the raw

scores obtained in Word Knowledge and Reading.

Word Knowledge measures the extent of the child's reading vocabulary. It consists of 35 items, each of which contain a picture of an object and four words. Children must underline the word which describes each picture.

Word Analysis consists of 40 items, designed to assess knowledge of phoneme-grapheme correspondence. Children are asked to find a word which has been dictated from several which have similar configurations.

Reading assesses comprehension of written material. Thirteen items require the correct choice of one sentence out of three to describe a picture. Twenty-nine items involve reading simple paragraphs and answering questions about their content.

Mathematics Part A includes 35 items which measure mathematical concepts such as counting, place value, sets, and measurement. Part B measures computational skills. Students are required to add and subtract one and two digit numbers with no regrouping.

Raw scores obtained on the Metropolitan Achievement Test may be converted to standard scores, grade equivalents, percentiles and/or stanines. In this study, data used from the Metropolitan included raw scores and standard scores obtained in Word Knowledge, Word Analysis, Reading and Mathematics.

VII STATISTICAL ANALYSIS OF DATA

The data were analyzed using computer programs set up by the Division of Educational Research Services of the University of Alberta using means, standard deviations, intercorrelations, one way analysis of variance, Cronbach's

coefficient alpha, pairwise contrast of means, and factor analysis. The .05 level of significance or beyond was accepted in this investigation. These statistics were used in the following instances.

A. Norming

Means and Standard Deviations

The means and standard deviations were calculated using the total sample, for the following:

a) Age .

b) Otis Lennon Intelligence Quotient.

c) Purdue Perceptual Motor Survey items, subtest totals and overall total score.

d) Metropolitan Achievement subtest and total test scores using raw scores.

e) Metropolitan Achievement subtest and total test scores using standard scores.

B. Pairwise Contrast of Means

Whenever comparison of independent groups was required, a one way analysis of variance was carried out to test the significance of the differences between the means. A Scheffe and Newman-Keuls test was performed on the means to determine between which means the differences were significant. The significance of the differences between the following groups were computed:

1. With the total score obtained on the Purdue as the

dependent variable, the father's occupation as the independent variable.

2. With the total score obtained on the Purdue as the dependent variable, the sex of the child as the independent variable.

C. Reliability

Cronbach's coefficient alpha was used in determining subtest and total test reliability of the Purdue Survey. Test-retest reliability was calculated using Pearson Product moment correlations obtained between subtest and total test scores.

D. Validation

Analysis of Variance

The scores of the 197 subjects on the 19 Purdue items were subjected to factor analysis, complete with rotations to a Varimax solution. The rotated factor loadings were then evaluated and identified.

E. Correlations

Pearson Product moment correlations between pairs of the following variables were computed:

a) Otis Lennon Intelligence Quotient and Purdue Survey items.

b) Purdue Survey items and Metropolitan Achievement subtest and total test scores.

These correlations were used in testing of the hypotheses listed

below.

VIII HYPOTHESES

In this section research hypotheses based on the theoretical framework presented in Chapter Two are presented. A null hypothesis follows each research hypothesis.

A. Research Hypothesis One

Academic achievement of Grade One children as assessed by the Metropolitan Achievement Test can be predicted by perceptual motor proficiency as assessed by the Purdue Perceptual Motor Survey.

Null Hypothesis One

1. There is no significant correlation between item scores obtained by grade one children on the Purdue Survey and subtest and total test scores o obtained on the Metropolitan Achievement Test.

2. There is no significant correlation between subtest scores obtained by grade one children on the Purdue Survey and subtest and total test scores obtained on the Metropolitan Achievement Test.

B. Research Hypothesis Two

There is a positive relationship between intellectual ability in grade one children as assessed by the Otis Lennon Mental Ability Test and perceptual motor proficiency as assessed by the Purdue Survey.

Null Hypothesis Two

1. There is no significant correlation between item scores

obtained by grade one children on the Purdue Survey and scores obtained on the Otis Lennon Mental Ability Test.

2. There is no significant correlation between subtest scores obtained by grade one children on the Purdue Survey and scores obtained on the Otis Lennon Mental Ability Test.

IX LIMITATIONS OF THE STUDY

Owing to limitations in time and personnel, final scoring of each survey was completed by this writer on the basis of a standard set of observations checked by the examiners. Since the survey aims at providing a qualitative evaluation of perceptual motor development, scores given could have been affected by this factor.

X SUMMARY

This chapter described the sample, the testing instruments, the methods of collecting data, the statistical analysis of the data, limitations of the study and proposed hypotheses of the study.

CHAPTER IV

RESULTS OF THE STUDY

This study attempted a norming and validation of the Purdue Perceptual Motor Survey, using a sample of normal grade one children. Relationships among perceptual motor proficiency, academic achievement and intelligence were also investigated. This chapter presents the findings of the study, as obtained through the statistical procedures outlined in Chapter III. The hypotheses presented in Chapter III will be restated and followed by the statistical results. In reporting the results of statistical analysis, the significance level of p = .05 was selected as the upper limit for rejecting each null hypothesis.

I NORMATIVE RESULTS

Table 2 presents the mean and standard deviation obtained for each item on the Purdue Survey.

TABLE 2

ITEM MEANS AND STANDARD DEVIATIONS
OF THE PURDUE PERCEPTUAL MOTOR SURVEY

	Item	Mean	Standard Deviation
1.	Forward	3.76	0.62
2.	Backward	2.74	0.94
3.	Sideways	2.90	1.30
4.	Jumping	2.00	1.06
5.	Identification of Body Parts	3.53	0.79
6.	Imitation of Movement	2.77	0.55
7.	Obstacle Course	3.25	1.07
8.	Kraus Weber	3.75	0.57
9.	Angels-in-the-Snow	2.21	0.95
10.	Circle	3.29	0.86
11.	Double Circle	2.43	1.09
12.	Lateral Lines	3.20	1.18
13.	Vertical Lines	3.25	1.00
14.	Both Eyes	3.25	1.21
15.	Right Eye	2.85	1.35
16.	Left Eye	2.89	1.37
17.	Convergence	3.57	1.00
18.	Form	2.36	0.72
19.	Organization	2.39	1.09

Table 3 presents the Purdue subtest and total test means and standard deviations.

TABLE 3

PURDUE PERCEPTUAL MOTOR SURVEY SUBTEST
AND TOTAL TEST MEANS AND STANDARD DEVIATIONS

	Subtest	Mean	Standard Deviation
1.	Balance and Posture	11.16	2.52
2.	Body Image and Differentiation	14.76	1.62
3.	Perceptual-Motor Match	12.24	1.63
4.	Ocular Control	13.21	3.63
5.	Form Perception	5.00	1.21
6.	Total Score	56.36	5.71

Table 4 includes mean total scores obtained on the survey by the various socioeconomic groupings. The analysis of variance of the group means is contained in Table 5.

TABLE 4

SES GROUP MEAN SCORES

Father's Occupational Grouping		n	Mean
Group I	Professional	9	54.44
Group II	Semi-Professional	44	58.48
Group III	Farmers	4	54.00
Group IV	Clerks, Service and Office Workers	62	56.69
Group V	Skilled Labour	61	55.62
Group VI	Unskilled Labour	17	53.94

TABLE 5

ANALYSIS OF VARIANCE ON TOTAL SURVEY SCORES
OBTAINED BY SES GROUPS

Source	m.s	df	F
Groups	78.38	5	1.81
Error	43.22	191	

The group means do not differ significantly as revealed by the analysis of variance.

The sample consisted of 99 males and 98 females. The total mean score obtained by males was 55.71 and the total mean score obtained by females was 57.03. These group means do not differ significantly as revealed by the analysis of variance (Table 6).

TABLE 6

ANALYSIS OF VARIANCE OF TOTAL SCORES
BY MALE AND FEMALE GROUPS ON THE PURDUE SURVEY

Source	m.s.	df	F
Groups	86.06	1	1.96
Error	43.91	195	

II RESULTS OF VALIDATION

Pearson Product Moment Correlations computed between Purdue Survey items, are contained in Table 7.

TABLE 7

*PEARSON PRODUCT MOMENT CORRELATIONS BETWEEN PURDUE PERCEPTUAL MOTOR SURVEY ITEMS

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Walking Forward		26[b]	10	03	13	03	21[b]	19[b]	00	11	09	08	11	02	11	08	03	06	-04
2. Walking Backwards			24[b]	15[a]	-03	09	07	-04	-09	07	08	04	03	21[b]	08	11	06	-03	14
3. Walking Sideways				08	04	11	06	06	-07	-04	10	02	03	17[a]	19[b]	04	08	-09	12
4. Jumping					07	20[b]	02	07	04	-02	02	07	-01	17[a]	29[b]	22[b]	08	02	15[a]
5. Body Identification						19[b]	-05	06	01	-02	03	-01	-06	-05	-07	-06	-08	-01	06
6. Imitation of Movement							02	10	06	02	01	03	-07	14[a]	09	10	-01	03	08
7. Obstacle Course								04	17[a]	03	-01	-10	04	02	08	04	08	09	-15
8. Kraus-Weber									12	16[a]	07	14	03	03	10	10	10	-11	-03
9. Angels-in-the-Snow										13	15[a]	-03	11	05	06	07	00	05	02
10. Chalkboard: Circle											14	03	23[b]	03	05	07	02	-02	00
11. Double Circle												17[a]	15[a]	10	05	08	00	09	07
12. Lateral Line													16[a]	03	06	08	07	01	13
13. Vertical Line														10	-02	03	-04	-06	06
14. Ocular Pursuit: Both Eyes															43[b]	39[b]	33[b]	-05	-06
15. Right Eye																51[b]	27[b]	01	-07
16. Left Eye																	13	15[a]	05
17. Convergence																		-06	-07
18. Form																			12
19. Organization																			

TABLE 7: continued

*Correlations have been rounded to two places and decimals omitted. Negative signs are indicated.

[a] Significant at 0.05 level.

[b] Significant at 0.01 level.

Low but significant correlations were found to exist between a number of survey items, with the strongest correlations noted between pairs of Ocular Control items. The latter finding is in agreement with Kephart's original study, as are the general weak correlations between most other items of the survey. Other significant correlations were found between Ocular Control and Balance and Posture items, as well as between Balance and Posture items and Body Image and Differentiation items.

The correlation matrix obtained on Purdue items was factor analyzed with a principal axis solution. The factors obtained in this solution were rotated to a varimax solution. The rotated factor loadings for each item were evaluated for size and clustering of loadings. Five basic factors were identified as being measured by the Purdue Survey. Table 8 presents the factor loadings of the 19 variables on the five factors.

TABLE 8

ROTATED FACTOR LOADINGS OF PURDUE SURVEY ITEMS

Variable		Factors[a]				
		I	II	III	IV	V
1.	Walking Forward	05	17	21	32	15
2.	Walking Backward	14	11	08	53	05
3.	Walking Sideways	15	04	13	42	09
4.	Jumping	36	- 01	24	13	07
5.	Identification of Body Parts	- 06	05	47	08	06
6.	Imitation of Movement	18	07	48	11	06
7.	Obstacle Course	06	08	05	09	09
8.	Kraus-Weber	13	21	34	01	- 04
9.	Angels-in-the-Snow	09	28	14	- 17	07
10.	Chalkboard: Circle	06	44	10	01	- 01
11.	Double Circle	07	37	06	09	14
12.	Lateral Line	07	32	08	09	11
13.	Vertical Line	02	49	- 03	09	- 01
14.	Ocular Pursuit: Both Eyes	58	13	04	20	- 07
15.	Right Eye	70	03	03	09	- 01
16.	Left Eye	63	12	03	03	19
17.	Convergence	32	06	03	08	04
18.	Form	08	05	06	- 02	45
19.	Organization	01	13	17	21	23

[a]Factor loadings have been rounded to two places and decimals omitted. Negative signs are indicated.

Factor I: Factor I was indicated by loadings of 0.58 on item 14, 0.70 on item 15, 0.63 on item 16, 0.36 on item 4 and 0.32 on item 17.

Factor II: Factor II was indicated by loadings of 0.44 on Chalkboard Circle, 0.37 on Double Circles and 0.49 on Vertical Line.

Factor III: Two items, Identification of Body Parts (0.47) and Imitation of Movement (0.48) loaded on Factor III. A weaker loading of 0.34 was obtained on the Kraus Weber item.

Factor IV: Factor IV was suggested by loadings of 0.53 on Walking Backward and 0.42 on Walking Sideways. A weaker loading of 0.32 was obtained on the Walking Forward item.

Factor V: Item 18, Form, loaded at 0.45 in indicating Factor V. A weaker loading of 0.23 was obtained on item 19, Organization.

III RELIABILITY

Test-retest reliability of subtests and of total test scores was investigated using Pearson Product Moment Correlations. Retest scores were obtained one week after the initial testing from a group of 28 children randomly selected from the original sample. Correlations ranged from .801 to .928.

Subtest and total test reliability, as computed using Cronbach's Alpha Coefficient, is presented in Table 9.

TABLE 9

SUBTEST AND TOTAL TEST RELIABILITY OF THE PURDUE SURVEY, USING CRONBACH'S ALPHA COEFFICIENT

	Subtest	Alpha Coefficient
1.	Balance and Posture	.38
2.	Body Image and Differentiation	.25
3.	Perceptual Motor Match	.40
4.	Ocular Control	.68
5.	Form Perception	.19
6.	Total Test	.59

IV HYPOTHESES

Pearson Product Moment Correlations, computed between Purdue items, are contained in Table 7. Pearson Product Moment Correlations computed between Purdue items, Metropolitan Achievement Test items and the Otis Lennon Mental Ability Test scores are contained in Table 10.

Hypothesis I

Academic achievement of grade one children, as assessed by the Metropolitan Achievement Test, can be predicted by perceptual motor proficiency as assessed by the Purdue Perceptual Motor Survey.

Pearson r's were used to determine correlations between item scores obtained on the Purdue and subtest scores obtained on the Metropolitan Achievement Test.

The results of this analysis, as shown in Tables 7 and 10, revealed weak but significant correlations between the following:

1. Walking Sideways: Word knowledge and mathematics.
2. Jumping: Word knowledge.
3. Body Identification: All subtests of the Metropolitan Achievement Test.
4. Angels-in-the-Snow: Total reading score.
5. Chalkboard-Vertical Line: Total reading score.
6. Ocular Pursuit - Both Eyes: Phonetic analysis.
7. Ocular Pursuit - Right Eye: Word knowledge, phonetic analysis, mathematics.

TABLE 10

PEARSON'S PRODUCT MOMENT CORRELATIONS BETWEEN PURDUE ITEMS, METROPOLITAN ACHIEVEMENT TEST ITEMS AND OTIS LENNON MENTAL ABILITY TEST SCORES

Purdue Items	Word Knowledge Raw Score	Phonetic Analysis Raw Score	Reading Raw Score	Math Raw Score	Total Reading Raw Score	Word Knowledge Standard Score	Phonetic Analysis Standard Score	Reading Standard Score	Math Standard Score	Total Reading Standard Score	I.Q
1. Walking Forward	03	-04	-02	01	07	04	-07	-02	-02	12	04
2. Walking Backward	03	01	02	02	-02	01	02	02	02	-01	-06
3. Walking Sideways	14[a]	05	09	11	07	15[a]	09	13	15[a]	06	06
4. Jumping	09	08	07	07	09	15[a]	08	12	13	09	07
5. Body Identification	19[b]	31[b]	23[b]	22[b]	17[a]	18[b]	25[b]	22[b]	21[b]	18[b]	22[b]
6. Imitation of Movement	01	06	-01	00	08	04	01	-04	01	12	03
7. Obstacle Course	-05	-06	-06	-06	-04	-08	-07	-05	-03	01	-03
8. Kraus-Weber	-03	-01	08	05	04	01	-05	11	08	05	05
9. Angels-in-the-Snow	11	07	07	09	15[a]	13	03	05	07	15[a]	08
10. Chalkboard: Circle	05	09	04	05	07	07	07	01	05	09	02
11. Double Circle	-01	-02	-07	-04	04	00	-07	-07	-03	01	-03
12. Lateral Line	-02	02	00	-01	09	01	03	-03	-02	07	-07
13. Vertical Line	-06	-01	02	-00	17[a]	-01	01	02	02	16[a]	07
14. Ocular Pursuit: Both Eyes	12	14[a]	09	09	09	13	12	07	07	06	-01
15. Right Eye	17[a]	16[a]	12	15[a]	12	11	05	13	14[a]	11	09
16. Left Eye	08	01	02	04	05	00	-12	-02	-02	04	-01
17. Convergence	00	09	04	03	07	03	08	06	02	05	-06
18. Form	15[a]	15[a]	11	13	27[b]	13	12	09	11	27[b]	21[b]
19. Organization											

8. Form: Phonetic analysis, total reading score.

On the basis of the analysis of data revealed in Tables 7 and 10, the null hypothesis is rejected and the research hypothesis is partially accepted.

Hypothesis II

There is a positive relationship between intellectual ability in grade one children, as assessed by the Otis Lennon Mental Ability Test, and perceptual motor proficiency, as assessed by the Purdue Survey.

Pearson r's were used to investigate the correlations between each of the 19 Purdue items and the intelligence quotient obtained on the Otis Lennon Mental Ability Test. The results of the computations, shown in Tables 7 and 10, reveal weak but significant correlations between the following:

1. Form and Otis Lennon I.Q.

2. Body Identification and Otis Lennon I.Q.

On the basis of this analysis of the data, the research hypothesis is partially accepted and the null hypothesis is rejected.

V DISCUSSION OF THE RESULTS

A. Means and Standard Deviations of Sample Data

The mean total I.Q. score for the sample population as obtained on the Otis Lennon Mental Ability Test was 115.95. Deviation I.Q.'s obtained on the Otis Lennon have a mean of 100 and a standard deviation of 16. This indicates that the sample population scored in the above-average range of intelligence as assessed by this group test (Otis & Lennon, 1968, p. 68). The

standard deviation in this sample for the Otis Lennon was 13.18 which is three points below that obtained by the original normative sample. The sample group used in this investigation had high intelligence scores and a more constricted range of scores than did the original sample.

The mean standard scores obtained in the subtests of the Metropolitan Achievement Test by this sample, when converted to grade equivalent scores, ranged from 2.1 to 2.7. This would appear to be within normal limits for students completing the first grade.

The total mean score obtained on the Purdue Survey was 56.36, with a standard deviation of 5.71. The range of perceptual motor performance scores presented by this sample was small.

B. Socioeconomic Status

The analysis of variance for group means on the Purdue for varying levels of socioeconomic status is presented in Table 5. The group means did not differ significantly as determined by this analysis. These results differ from those of Kephart's normative sample, in which significant differences were found between SES Groups IV, V, and VI. These results should be interpreted with some caution due to the low number of children in Groups I and III.

The lack of differences among SES groups in this sample may be accounted for by several factors. In over 80% of the sample homes both parents worked. If an analysis of SES grouping according to maternal occupation had been undertaken, the size of each group would have varied from those which were presented in this study. A statement of SES grouping would have been difficult

since in many instances parents would be placed in different SES groupings.

The criteria used in determining placement could also be questioned, particularly when considering groups III, IV, and V. Group V contained those who were classified as being skilled laborers and included plumbers, carpenters and electricians. In terms of the number of years of post-secondary education required for qualification and yearly income, this group could more validly be replaced by Group IV, which included clerks, service and office workers. The rationale for placing farmers in a separate group is unclear. The distinction between this Group and Group V could also be argued.

It is suggested that a more refined method of determining SES grouping, taking into account occupation of the family's second wage earner and years of post-secondary education, could have been used in this study.

C. Sex

The analysis of variance on group means of the total Purdue score obtained according to sex is presented in Table 6. The group means did not differ significantly as determined by this analysis. These findings are in agreement with those obtained by Roach and Kephart in the original norming.

Observations by the examiner during testing suggested that a comparison by sex of scores obtained on each item of the Purdue might reveal sex differences in certain areas. Gesell (1940) found that girls at this age level had more difficulty with walking board activities than did boys. Beery (1967) noted that boys consistently lagged in development of visual-motor integration skills, as determined by form copying.

D. Validation

Analysis of the Pearson Product Moment Correlations noted in Table 7 suggested statistical support for the theoretical construct of Ocular Control. The four items used to assess this facet of perceptual-motor proficiency obtained the highest intercorrelations found in this particular sample. This finding is in agreement with those of the original study, as well as later research which was discussed in Chapter Two.

In general, other intercorrelations obtained with this sample were much weaker than those of the original study. This may be related to the wider age range found in the original sample.

Other significant intercorrelations were noted between walking board items, suggesting support for the posited construct of Balance and Posture. Inclusion of the Jumping item within this subtest may be questioned in view of the stronger correlation found between it and three of the Ocular Control items. Correlations were also found between other walking beam items and Ocular Control items. This suggests that Balance and Posture are related in some way to Ocular Control, an assumption which finds support in the work of neuropsychologists:

> Vestibular nerves are related not only to posture and equilibrium; they also control the movements of the eyes.... In summary, the vestibular apparatus plays an important role in posture, acting chiefly through vestibular-oculomotor pathways (in order to control eye movements) and through vestibular-spinal tracts (in order to control equilibrium) (Quiros & Schrager, 1978, p. 70-71).

This relationship is also noted by Ayres (1975, p. 328):

> All of the therapeutic endeavors directed toward normalization of the vestibular system and postural mechanisms also have a positive influence on the extra-ocular muscles at the same time.

Significant intercorrelations were also found between chalkboard items designed to assess Perceptual-Motor Match. However, the correlations noted between the Angels-in-the-Snow item, Chalkboard-Double Circle and Vertical Line items are of particular interest. All of the latter group involve integration of functioning of the two sides of the body. These particular items may be tapping a separate aspect of perceptual motor functioning-bilateral coordination and integration.

Of the five survey items designed to assess Body Image and Differentiation, significant correlations were noted between Body Identification and Imitation of Movement, and between Obstacle Course and Angels-in-the-Snow. These results suggest that the five items are focusing on three separate aspects of perceptual-motor functioning.

Analysis of factor loadings of Purdue items generally suggested support for the five constructs proposed by Kephart. Some exceptions to this were also noted, indicating that modifications to the survey may result in greater factorial validity and better application of survey results.

Factor I can be identified as Ocular Control. As was previously suggested by analysis of Pearson Product Moment Correlations, the Jumping item loaded on this particular factor. Performance on the Jumping item

appeared to be much more closely related to Ocular Control than to Balance and Posture items.

Factor II, determined by loadings on Angels-in-the-Snow and all Chalkboard items, can be defined as Perceptual-Motor Match. Although Angels-in-the-Snow loaded more heavily on this factor than it did on any other, the loading is statistically weak. For this reason, its inclusion as part of the Perceptual-Motor Match subtest would be questionable. Its weighting does suggest that performance in the five items may be related to the development of body differentiation and to bilateral coordination.

Two items, Identification of Body Parts and Imitation of Movement, loaded on Factor III, which may be defined as Body Image and Differentiation. A weaker loading was found on the Kraus-Weber item. The Obstacle Course item, originally included in the Body Image and Differentiation subtest, did not load significantly on any of the five factors. It appears to be tapping a different aspect of perceptual motor functioning not previously identified by Kephart.

Three of the walking beam items, Forwards, Backwards and Sideways, loaded on Factor IV. This factor was defined as Balance and Posture by Kephart. The Jumping item, which was originally included in this subtest, did not load significantly on this factor. As was previously noted, the Jumping item appears to focus on aspects of perceptual-motor functioning which are related more closely to Ocular Control than to Balance and Posture.

Factor V was identified by loading on the Form item. This factor may be defined as Form Perception. The item Organization which was included in this subtest loaded more heavily on this factor than did any of the other survey items. However, the loading was very weak.

E. Reliability

Subtest and total test reliabilities as computed using Cronbach's Alpha Coefficient, are contained in Table 9.

These results indicate that Ocular Control is the most reliable subtest of the Purdue Survey. The intercorrelations obtained between the items of this subtest suggested that they are relatively homogeneous in nature.

The least reliable subtest was Form Perception. The reliability of this item could have been affected by the amount of subjectivity allowed by the scoring criteria. This factor was alluded to by the authors of the survey. The scores obtained on this item were based on copying of five geometric figures. This limited sampling of perceptual-motor functioning may also have affected reliability.

Increased reliability could be expected on the other subtests if modifications were made in accordance with the Factor loading results which were discussed in the previous section. These modifications would increase the homogeneity of the items contained in each subtest.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS FOR FUTURE RESEARCH

I. SUMMARY

A. Statement of the Problem

This study attempted a norming and validation of the Purdue Perceptual Motor Survey, using a sample of normal grade one children.

B. Collection of Data

Nineteen selected items of the Purdue Survey were individually administered to 197 grade one students in November of 1978. The Survey was readministered to a group of 28 children randomly selected from the original sample one week after the initial testing. The Otis Lennon Mental Ability Test and Metropolitan Achievement Test were administered as group tests to the total sample in May of 1979. Classification with respect to socioeconomic status was made in accordance with the criteria used by Kephart and Roach in the original norming of the Survey.

C. Analysis of Data

Means and standard deviations were computed for all item, subtest and total scores of the Purdue; raw scores and standard scores were obtained

on the Metropolitan subtests; and Intelligence scores as determined by the Otis Lennon Mental Ability Test were calculated.

A one-way analysis of variance was carried out to determine significance of difference between group means on the Purdue according to socioeconomic status and sex. Pearson product moment correlations were computed between pairs of items of the Purdue. Factor analysis was used to investigate the validity of the five constructs used in the Purdue: Balance and Posture, Body Image and Differentiation, Perceptual-Motor Match, Ocular Control and Form Perception.

Subtest and total test reliability of the survey was computed using Cronbach's coefficient alpha. Test-retest reliability was computed using Pearson product-moment correlations.

Intercorrelations between scores obtained on Survey Items, Metropolitan Achievement Test items and Intelligence scores were investigated using Pearson product moment correlations.

II CONCLUSIONS

A. Conclusions with Respect to Differences in Group Means According to Socioeconomic Status

The analysis of variance on group means, using the total Purdue scores, obtained according to SES, indicated that there was no significant difference between groups used in this study. This conclusion was affected by the following factors:

1. Groups I and III contained a very small number of children;
2. In over 80% of the sample homes, both parents worked. No

consideration was given in the criteria determining SES Grouping for maternal occupation. Had this factor been considered, sizes of the various groups would have been altered.

3. The criteria used in determining SES Grouping III, IV, and V are not specific either in terms of family income or in years of secondary education obtained. Had these been given consideration, results of the analysis of variance may have differed from those obtained.

B. Conclusions with Respect to Differences in Group Means According to Sex

The analysis of variance on group means using total Purdue scores and obtained according to sex determined there was no significant difference among the groups used in this study. These findings are in agreement with those of the original study carried out by Roach and Kephart. There is some evidence from previous research which suggests that comparison by sex on performance on various Purdue items rather than the total test score, might conclude in noted sex differences.

C. Conclusions with Respect to Validation

Factor analysis and intercorrelations obtained between Purdue items suggested general statistical support for the five constructs of perceptual motor functioning proposed by Kephart.

Some modifications to the structure of the survey were suggested by the factor analysis. The factors identified and items contributing to their weighting were:

Factor I - Ocular Control: This included the four items from the original survey; tracking with both eyes, the right eye; the left eye; and convergence. The Jumping item, originally included in the Balance and Posture subtest, loaded on this factor. Its future inclusion as one of the Ocular control items would be of limited value in terms of contributing to the reliability or validity of this particular subtest. Its weighting is of interest in that it suggests a relationship between Ocular Control and Posture and Equilibrium. This relationship was further suggested by the significant Pearson r's found between Balance Board activities and Ocular control items. However, the Walking Board activities did not load significantly on the Ocular Control factor.

Factor II - Perceptual Motor Match: This included the Chalkboard items: Circle, double circle, lateral line and vertical line. Angels-in-the-Snow, an item from the subtest Body Image and Differentiation, loaded on this factor, suggesting that tasks included in this subtest may be focusing on body differentiation and bilateral coordination.

Factor III - Body Image and Differentiation: Two of the five items originally included in this subtest, Identification of Body Parts and Imitation of Movement, loaded on Factor III. Angels-in-the-Snow loaded on Factor II but Obstacle Course did not load significantly on any of the five factors. The Kraus Weber item loaded very weakly on Factor III.

Factor IV - Balance and Posture: Loadings on this factor were noted on three of the four original items, Walking Forwards, Backwards and Sideways. The fourth item, Jumping, loaded on Factor I.

Factor V - Form Perception: The item Form loaded on this factor. A much weaker loading was obtained on the second item of this subtest, Organization.

On the basis of results of the factor analysis and significant Pearson r's noted between Purdue items, the following revised format is posited as offering increased factorial validity:

Subtest 1 Balance and Posture

Items: 1. Walking Forward
2. Walking Backwards
3. Walking Sideways

Subtest 2 Body Image and Differentiation

Items: 1. Identification of Body Parts
2. Imitation of Movement

Subtest 3 Ocular Control

Items: 1. Both eyes
2. Right eye
3. Left eye
4. Convergence

Subtest 4 Perceptual Motor Match

Items: 1. Circle
2. Double circle
3. Lateral Line
4. Vertical Line
5. Angels-in-the-Snow

Subtest 5 Form Perception

Item: 1. Form

D. Conclusions with Respect to Reliability

Cronbach alpha coefficients were computed on the Purdue subtest and total test scores. With the exception of Ocular Control, the internal consistency of the subtests was weak. The coefficients obtained would most likely increase with modification of the subtest content as suggested by the previously discussed factor analysis.

The coefficient computed on the subtest Form Perception was the lowest (0.19) of all five subtests. The reliability of this item may have been affected by the degree of subjectivity allowed in scoring and by the limited number of geometric forms which were administered. A more objective method of scoring, which might include evaluation of accurateness in angulation, closure, and ratios of length to width, could also have resulted in improved reliability.

The Pearson r's used to compare test-retest scores were consistent in suggesting a high coefficient of stability. The coefficient obtained represented the degree of stability between examiners, since children in the retest sample group were not assessed by the original examiner.

E. Conclusions with Respect to Hypothesis One

For this sample of grade one children, a weak but statistically significant correlation between certain aspects of perceptual motor functioning and academic achievement was found.

Results of this study suggest that several items of the Purdue

may be useful as predictors of grade one achievement, particularly in the subject area of reading.

The item which consistently related to academic achievement was Identification of Body Parts. Two Ocular Pursuit items, Tracking with Both Eyes and the Right Eye, correlated with end of year academic scores in Reading subtests. The Right Eye item also correlated with mathematics achievement. Two of the Balance and Posture items, Walking Sideways and Jumping, also correlated with achievement in reading. The interrelationships of these two items with Ocular Control has previously been discussed. Two items which appear to be related to bilateral coordination, Angels-in-the-Snow and Chalkboard Vertical Line, correlated with reading achievement. The two items in the subtest Form Perception correlated significantly with reading achievement scores. Although this correlation has been noted in other previously mentioned studies, the results in this particular case must be interpreted with caution in view of the subtest's limited reliability.

To summarize, eight of the 19 Purdue items administered in this study correlated with academic achievement. All eight items correlated with aspects of reading achievement, while only two correlated with mathematics achievement. The areas of perceptual motor functioning which correlated with academic achievement were Ocular Control, Balance, Bilateral Coordination and the item Body Identification.

The value of the Kraus-Weber and Obstacle Course items was very limited with respect to this sample population. Neither item loaded significantly on any of the five factors identified in this investigation, and neither correlated with any aspect of academic achievement.

F. Conclusions with Respect to Hypothesis Two

For this sample of grade one children, a weak but statistically significant correlation was found between certain aspects of perceptual motor functioning and intelligence. Two items of the Purdue, Identification of Body Parts and Form, correlated with Intelligence as assessed by the Otis Lennon Mental Abilities Test.

Identification of Body Parts was consistently the best predictor of intelligence and academic achievement in the sample used in this study.

III IMPLICATION FOR FUTURE RESEARCH

The results of this study can be applied to grade one students within the County of Strathcona. Generalizations beyond the County should be made with caution.

The findings in general support the five constructs of perceptual motor functioning proposed by Kephart and Roach in the Purdue Survey. Factor analysis carried out on Purdue items revealed that modification of item content to the subtests Balance and Posture, Body Image and Differentiation, Perceptual-Motor Match, and Form Perception might result in improved construct validity and reliability. A further, large scale investigation of the survey using a sample representing a wider age range could be useful in determining the value of these modifications.

When this grade one sample was analyzed according to sex, no

significant difference was found between group means on total test scores. It is suggested that on the basis of previous research discussed in Chapter IV, further research might include comparison of item scores by sex as opposed to restricting comparison to total scores obtained.

No significant difference was noted in this study when comparisons of perceptual motor proficiency were made according to socioeconomic status. Further study which includes investigation of this relationship is warranted, in which more stringent criteria for SES grouping are used.

The results of this study partially support the assumption that significant relationships exist between perceptual motor proficiency and both intelligence and academic achievement. Analysis of the Purdue items revealed that eight were useful in predicting academic achievement in this sample. The eight items were part of the two subtests Balance and Ocular Control. Two of these items apparently related to Bilateral Coordination, Angels-in-the-Snow and Chalkboard Vertical Line, were of predictive value. The Identification of Body Parts item was the most consistent predictor of academic achievement. The other items contributed little in terms of increasing predictive power of the survey.

Although two items, Identification of Body Parts and Form correlated with intelligence, it was suggested that limited weight be given to the predictive value of the Form item due to extremely weak reliability.

Future investigation of additional Perceptual Motor items, particularly those related to bilateral coordination, could result in the formulation of more efficient and powerful subtests.

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GLOSSARY

GLOSSARY

Bilateral Coordination: Bilateral coordination refers to the ability to use both sides of the body in a simultaneous and parallel fashion (Chaney & Kephart, 1968, p. 134).

Intelligence: Intelligence is operationally defined in this study as the students scores obtained on the Otis Lennon Mental Ability Test. The authors of this group test stress that it should not be considered an instrument measuring innate mental capacity, but instead refer to assessment of broad reasoning abilities which are related to scholastic aptitude.

Kinaesthesis: Kinaesthesis refers to the perception of movement, weight, and position. Practically, it refers to body information provided by motor activities and movement (Quiros and Schrager, 1978, p. 249).

Perceptual-Motor: This refers to the integration of motor cues, sensory information, and movement. The perceptual-motor process is viewed by Kephart (1968) as involving both sensory or perceptual input and motoric output. Input and output are linked closely. Proficiency in perceptual-motor areas refers to the level of development achieved in each. In the present study, perceptual-motor proficiency is defined in terms of subtest and total test scores obtained on the Purdue Perceptual Motor Survey.

Proprioception: Proprioception refers to the sensitivity which provides information coming from nervous endings localized in muscles, tendons, and joints related to movements and body positions (Quiros and Schrager, 1978, p. 252).

Vestibular Apparatus: The vestibular apparatus, the non-auditory organ of the inner ear, is sensitive to posture, equilibrium, and orientation to environmental space (Quiros and Schrager, 1978, p. 256).

APPENDICES

APPENDIX A

PURDUE PERCEPTUAL MOTOR SURVEY:

SCORING FORMAT

Name: ____________ Date of Birth: ____________

Address: ____________ Sex: ____ Grade: ____________

____________ School: ____________

Examiner: ____________ Date of Examination: ____________

Phone: ____________ Father's Occupation: ____________ Attended Kgn: ____

* *

SCORE

	4	3	2	1	
Walking Board: Forward					Balance and Posture
Backward					
Sidewise					
Jumping					
Identification of Body Parts					Body Image and Differentiation
Imitation of Movement					
Obstacle Course					
Kraus-Weber					
Angels-in-the-snow					
Chalkboard: Circle					Perceptual-Motor Match
Double Circle					
Lateral Line					
Vertical Line					
Rhythmic writing Rhythm					
Reproduction					
Orientation					
Ocular Pursuits: Both eyes					Ocular Control
Right eye					
Left eye					
Convergence					
Visual Achievement Forms: Form					Form Perception
Organization					

BALANCE AND POSTURAL FLEXIBILITY

1. WALKING BOARD

FORWARD

Walks easily, maintains balance	______	Comments:
Steps off board twice	______	
Pauses frequently, difficulty regaining balance	______	
Avoids Balance:		
Runs	______	
Long Steps	______	
Feet crosswise of board	______	
Maintains inflexible posture	______	
Occasional difficulty, but regains balance	______	
Cannot perform, or more than ¼ of his performance out of balance	______	Score

BACKWARD

Steps off board three times	______	Comments:
Pauses frequently	______	
Uses one side of body more consistently than other	______	
Twists body to see where he is going; looks behind himself	______	
Must feel with toe	______	
Maintains inflexible posture	______	
Walks easily, maintains balance without looking behind	______	
Has occasional difficulty, but is able to regain balance	______	
Child cannot perform	______	
More than ½ of performance out of balance	______	Score

SIDEWISE			
Steps off board more than twice in one direction	______	Comments:	
Performs much more easily in one direction than the other:			
Right lead	______		
Left lead	______		
Walks easily in either direction	______		
Occasional difficulty, but regains balance	______		
Pauses frequently	______		
Difficulty regaining balance	______		
Child cannot perform	______	Score	[ ]
Performance markedly out of balance	______		

2. JUMPING (Demonstrate)

BOTH FEET			
Cannot keep feet together	______	Comments:	
Uses one side of body only	______		
"Ties" one side of body to the other	______		
Performs easily	______	Score	[ ]
Cannot perform	______		

ONE FOOT			
Postural shift not smooth	______	Comments:	
Cannot keep opposite foot off the floor	______		
Performs adequately:			
Right foot	______	Score	[ ]
Left foot	______		

SKIP			
Movement not free	______	Comments:	
Hesitates after each step to determine which side to use	______		
Performs adequately	______	Score	[ ]

HOP (30 seconds)

	Hop 1/1	Hop 2/2	Hop 2/1 Beg R.foot	Hop 2/1 Beg L.foot
Cannot remain in one spot while performing	______	______	______	______
Cannot shift easily from side to side	______	______	______	______
Movements jerky and lack rhythm	______	______	______	______
Performance adequate	______	______	______	______

Comments:

Score

BODY IMAGE AND DIFFERENTIATION

3. IDENTIFICATION OF BODY PARTS

Performs adequately throughout ______

Shows only slight hesitancy or confusion ______

Shows hesitancy in one or more responses (except elbows) ______

Does not touch both members of paired parts ______

Must "feel around" to find parts ______

Makes more than one error in identification; unable to identify parts ______

Comments:

Score

4. IMITATION OF MOVEMENT

Not consistent (sometimes mirror sometimes parallel) ______

Shows hesitation or lack of certainty ______

Makes abortive movements ______

Performs promptly, consistently, and suitably on all patterns-parallels examiner ______

Performs promptly, consistently and surely, but mirrors examiner ______

Comments:

Score

5. OBSTACLE COURSE

GOING OVER

Overestimates more than 2-2½ inches (steps too high)	______	Comments:
Catches foot on bar	______	
Cannot correct on one repetition	______	
Performance adequate	______	
Makes slight error and corrects	______	Score
Able to correct on one repetition	______	

GOING UNDER

Knocks bar off	______	Comments:
Bends too high to clear bar	______	
Cannot correct on one repetition	______	
Performance adequate	______	Score
Makes slight error and corrects	______	
Able to correct on one repetition	______	

GOING BETWEEN

Performance adequate	______	Comments:
Makes slight error and corrects	______	
Able to correct on one repetition	______	Score
Cannot correct on one repetition	______	

6. KRAUS-WEBER

Cannot raise chest and hold	______	Comments:
Cannot raise legs and hold	______	
Raises chest and holds	______	Score
Raises legs and holds	______	

7. ANGELS-IN-THE-SNOW

	Task 1	2	3	4	5
Performs Adequately	____	____	____	____	____
Slight hesitation	____	____	____	____	____
Overflow into other limbs	____	____	____	____	____
Marked hesitation	____	____	____	____	____
Cannot perform	____	____	____	____	____
Can correct on one repetition	____	____	____	____	____
Requires tactual information as well as visual information	____	____	____	____	____
Must "bang" limb on floor to identify it	____	____	____	____	____
Movements do not reach maximum extension	____	____	____	____	____

	Task 6	7	8	9	10
Performs Adequately	____	____	____	____	____
Slight hesitation	____	____	____	____	____
Overflow into other limbs	____	____	____	____	____
Marked hesitation	____	____	____	____	____
Cannot perform	____	____	____	____	____
Can correct on one repetition	____	____	____	____	____
Requires tactual information as well as visual information	____	____	____	____	____
Must "bang" limb on floor to identify it	____	____	____	____	____
Movements do not reach maximum extension	____	____	____	____	____

Comments:

Score [ ]

PERCEPTUAL-MOTOR MATCH

8. CHALKBOARD

CIRCLE

Does not reach proper size	_____	Comments:
Direction incorrect for hand used	_____	
Drawing not directly in front of child	_____	
Does not cross midline	_____	
Shape of circle not accurate	_____	
Still shows difficulty after 3 or 4 attempts but produces acceptable drawing	_____	
Circle drawn in proper size, direction, position & shape. One additional instruction allowed.	_____	
Good circle after 2 or 3 attempts. (crosses midline; proper size)	_____	Score
Unable to produce acceptable drawing	_____	

DOUBLE CIRCLE

Does not reach proper size	_____	Comments:
Circles overlap	_____	
One circle larger than the other	_____	
Circles drawn one on top of the other	_____	
Direction incorrect:		
Hands parallel	_____	
Opposite but wrong direction	_____	
Circles flat toward inside	_____	
Visual attention directed to one hand	_____	
Movement of two arms not synchronized	_____	
Performance smooth & certain. No more than one additional direction to achieve size & position.	_____	
2 or 3 trials necessary, performance stiff	_____	
Performance does not become acceptable within 2 or 3 trials.	_____	
Unable to perform	_____	Score
Extreme difficulty on any part of performance	_____	

LATERAL LINES

"Walks" across the board ______

Draws left half with left hand, right half with right hand ______

Pivots body to avoid crossing midline ______

Difficulty when hand is on opposite side of midline ______

False starts ______

Pauses and confusion ______

Performance adequate ______

Slight hesitancy, inaccuracy ______

Marked hesitancy or inaccuracy ______

Cannot perform ______

Comments:

Score

VERTICAL LINES

Lines bow:

Slightly ______

Markedly ______

Visual attention to one hand only ______

One hand ceases to function during performance ______

Hands move alternately, not simultaneously ______

Adequate performance, both lines straight & parallel ______

Adequate performance after hesitation and thinking about movement ______

Cannot perform ______

Comments:

Score

OCULAR CONTROL

9. OCULAR PURSUITS

	Task 1 Both Eyes	Task 2 Right Eye	Task 3 Left Eye
Smooth, even, following movements	____	____	____
Basically smooth, slight hesitation, jerkiness	____	____	____
Uneven, jerky movements	____	____	____
Unable to follow target. Loses target (overshoots or undershoots)	____	____	____
Moves head Instead of eyes	____	____	____
Eyes do not work together	____	____	____
One eye leads other markedly	____	____	____
One eye stays still as other moves	____	____	____

Scores:

Both eyes [ ]

Right eye [ ]

Left eye [ ]

	Task 4 - Convergence
Smooth, even movement	____
Basically smooth, slight delay or inaccuracy	____
Movement jerky, unsure	____
Eyes break apart or do not converge	____

Convergence [ ]

Comments:

FORM PERCEPTION

10. VISUAL ACHIEVEMENT FORMS

FORM

	1	2	3	4	5
Changes orientation of paper to alter direction of movement	____	____	____	____	____
Segments drawings	____	____	____	____	____
Internal lines of divided rectangle segmented	____	____	____	____	____
"Ears" on forms	____	____	____	____	____
Drawings markedly larger or smaller than copy	____	____	____	____	____

Comments:

Score

ORGANIZATION

No discernible organization ____

Comments:

Organization on page is:

Left to right ____

Vertical ____

Circular ____

Score